



UNIVERSITI PUTRA MALAYSIA

**THE ARBUSCULAR MYCORRHIZA AND PHOSPHATE ROCK IN
REHABILITATION OF TIN TAILINGS WITH *ACACIA MANGIUM*
AND PEANUT AGROFORESTRY SYSTEM**

MD. ABDUS SATTER

FP 2000 20

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REHABILITATION OF TIN TAILINGS WITH *ACACIA MANGIUM*
AND PEANUT AGROFORESTRY SYSTEM**

By

MD. ABDUS SATTER

**Thesis Submitted in Fulfilment of the Requirements for the
Degree of Doctor of Philosophy in the Faculty of Agriculture
Universiti Putra Malaysia**

October 2000



***DEDICATED TO
MY MOTHER
AND
DEPARTED SOUL OF MY FATHER***

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy.

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October 2000

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Faculty: Agriculture

Malaysia has a vast area (200,000 ha) of abandoned barren sandy tailings unsuitable for agriculture and forestry. An attempt was made to convert these lands into a sustainable production system through establishment of *Acacia mangium* and peanut agroforestry system. The effect of arbuscular mycorrhiza (AM) in combination with P fertilization was studied on mangium seedlings in the glasshouse and on sole mangium and mangium + peanut agroforestry system on the sandy tailings in the field. Gafsa (GPR) and China (CPR) phosphate rocks along with TSP and control were tested with and without AM on mangium seedlings planted on the sandy tailings in the glasshouse. Growth, nodulation and nutrition of mycorrhizal seedlings were significantly higher than nonmycorrhizal seedlings. Gafsa PR and TSP with AM produced superior seedlings compared to the other treatments probably due to higher P release from these two P sources. Mycorrhizal seedlings given GPR and TSP attained a height of 30 cm (recommended for

outplanting) within 65 days compared to 85 days for nonmycorrhizal seedlings. The cheaper GPR with AM was hence recommended. In another trial, six P rates (0, 20, 40, 60, 80 and 100 mg P kg⁻¹ soil) in combination with two AM treatments were evaluated. Gafsa PR at 50 mg P kg⁻¹ soil with AM was suggested for raising mangium seedlings on sandy tailings. Five rates of AM inoculum (0, 15, 30, 45 and 60 g plant⁻¹) were then tested on peanut on the sandy tailings in the glasshouse. An inoculum level of 20 g plant⁻¹ was decided for field application. Field performance of AM inoculated and uninoculated mangium seedlings given 0, 50 and 100 g GPR plant⁻¹ were further evaluated in the sole culture for 160 days, and in association with peanut from 200 to 290 days after planting (DAP). Growth performance of inoculated and uninoculated mangium plants was similar until 70 DAP, but from 100 DAP onwards mycorrhizal plants had significantly higher growth with maximum growth obtained at 50 g GPR plant⁻¹. This combination is therefore recommended as optimum for mangium in the field. Yield of AM associated peanut grown at 185 to 285 DAP under mangium was significantly higher. This increased steadily from 1.18 to 1.63 t ha⁻¹ with increase in GPR from 0 to 100 kg P ha⁻¹. Hence, 100 kg P ha⁻¹ from GPR with AM has been suggested for the associated peanut. Organic matter and nutrient contents of the soil also improved under this agroforestry system, thus converting barren sandy tailings into a sustainable production system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah.

**ARBUSKULAR MIKORIZA DAN BATUAN FOSFAT DALM
PNEBUSGUNAAN TANAH BEKAS LOMBONG MENGGUNAKAN
SISTEM AGROHUTAN *ACACIA MANGIUM* DAN KACANG TANAH**

Oleh

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Malaysia mempunyai kawasan terbiar yang gersang (seluas 200,000 ha) hasil dari aktiviti perlombongan bijih timah yang tidak sesuai untuk pertanian dan perhutanan. Satu usaha diambil untuk menukarkan kawasan ini kepada satu sistem pengeluaran lestari menerusi penanaman *Acacia mangium* dan kacang tanah di bawah sistem hutantani. Kesan kombinasi mikoriza arbuskul (MA) dengan pembajaan P telah dikaji ke atas anak benih mangium di rumahkaca; hanya mangium dan gabungan mangium dengan kacang tanah pada tanah pasir bekas lombong di ladang. Batuan fosfat Gasfa (GPR) dan China (CPR) bersama tripel superfosfat (TSP) dan kawalan diuji ke atas anak benih mangium dirawat MA atau tanpa MA pada tanah pasir bekas lombong di rumahkaca. Pertumbuhan, pembintilan dan pemakanan anak benih bermikoriza adalah lebih baik daripada tanpa mikoriza. Batuan GPR dan TSP bersama MA menghasilkan anak benih yang lebih besar berbanding rawatan lain. Ini mungkin disebabkan pembebasan P yang lebih tinggi daripada kedua punca P tersebut. Ketinggian anak benih bermikorhiza

bersama GPR dan TSP mencapai 30.0 cm (ketinggian paling sesuai untuk dipindahkan ke ladang) dalam masa 65 hari berbanding 85 hari tanpa mikoriza. Berdasarkan harga GPR yang murah, kombinasi GPR-AM adalah disyorkan. Dalam kajian lain, penggunaan enam paras P (0, 20, 40, 60, 80 dan 100 mg P kg⁻¹ tanah) bersama dua rawatan AM telah dinilai. Gabungan MA dengan 50 mg P kg⁻¹ tanah (dari GPR) adalah sesuai untuk tumbesaran anak benih mangium di tanah bekas lombong. Lima paras inokulum MA (0, 15, 30, 45 dan 60 g pokok⁻¹) seterusnya diuji ke atas kacang tanah di rumah kaca. Paras inokulum ditahap 20 g pokok⁻¹ dianggap sesuai untuk penggunaan di ladang. Kesesuaian anakbenih mangium di ladang yang dirawat dengan atau MA disamping GPR pada tanpa paras 0, 50 dan 100 g pokok⁻¹ dinilai seterusnya selama 160 hari selepas menanam (DAP) untuk mangium sahaja; dan dari 200 hingga 290 DAP untuk campuran mangium-kacang tanah. Tumbesaran anak benih mangium dengan atau tanpa MA didapati serupa sehingga 70 DAP. Selepas 100 DAP ke atas, anak benih bermikoriza memberikan pertumbuhan yang lebih bererti dan maksimum pada paras 50 g GPR pokok⁻¹. Kombinasi ini adalah paling optimum bagi penghasilan mangium di ladang. Hasil kacang tanah bermikoriza mulai 185 hingga 285 DAP di bawah mangium adalah lebih tinggi dan bertambah secara sekata daripada 1.18 ke 1.63 tan ha⁻¹ dengan pertambahan kadar GPR daripada 0 ke 100 kg P ha⁻¹. Berikutnya, paras 100 kg P ha⁻¹ bersama AM disyorkan untuk kacang tanah bersama mangium. Kandungan bahan organik dan nutrient tanah turut meningkat di bawah sistem hutantani, selanjutnya mengubah tanah bekas lombong yang gersang kepada satu sistem pengeluaran lestari.

ACKNOWLEDGEMENTS

Praise to almighty Allah for His blessings Who enabled me to attain this highest academic degree.

I wish to express my deepest gratitude and sincere appreciation to Professor Dr. Azizah Hashim, the Chairman of Supervisory Committee for her knowledgeable guidance, constant encouragement, invaluable suggestions and generous help throughout the study period and in preparing this manuscript.

Sincere appreciation also goes to Dr. Mohamed Hanafi Musa, Associate Professor and Dr. Mahmud Tengku Muda Mohamed, Senior Lecturer, the members of Supervisory Committee for their constructive suggestions and guidance in formulation and execution of the research project and critically reviewing the manuscript.

To Dr. M.A. Saleque, I wish to express my sincere gratitude for his invaluable advice in formulating the research project. My sincere thanks are also due to individuals in the Faculty of Agriculture, UPM, especially to Professor Shamshuddin Jusop, Dr. A.R. Zaharah, Dr. Mohd. Fauzi Ramlan, Dr. Che Fauziah Ishak, for their individual discussions during the course of my study. Thanks are due to Dr. A.B. Rosenani for providing peanut seed and to the Dept. of Forestry for *Acacia mangium* seed to carry out my research project.

I appreciate the help and cooperation of my Lab. colleagues, Dr. Mohd. Imran Khan, Dr. Munwar Fazal, Miss. Wan Zaliha Wan Sembok and Mrs. Maria Viva Rini. I also acknowledge the help of technical staff of the Faculty of Agriculture, UPM, especially Mr. Abdul Aziz, Mr. Mazlan, Mr. Azhar, Mrs. Fauziah, Mr. A. Rahim, Mr. Jamil and others during execution of the study.

I am thankful to all of my friends and colleagues, especially to Mr. M. I. Khalil, Dr. A.H.M. Razzaque, Mr. Md. Mahfuzul Haque and Mr. M.A. Baset Miah for their help and moral encouragement. I want to express my indebtedness to Mr. Md. Abul Hossain Molla and his family for providing me with immense help and homely atmosphere especially at the later part of my study.

I am indebted to my family, particularly to my elder brother without whose spiritual support and sacrifices I would not have been able to reach this highest academic degree. I am also grateful to my wife, Rafeza Khatun and son, Md. Tariq Hasan for their immense help, encouragement, inspiration, patience, unfailing support and sacrifices.

I acknowledge the Faculty of Agriculture, UPM for the premises and facilities to accomplish the degree. I am grateful to the Bangladesh Agricultural Research Institute for providing me deputation to carryout the study. Last but not the least I am indebted to The Ford Foundation for giving me scholarship to accomplish the degree.

I certify that an Examination Committee met on 5 October 2000 to conduct the final examination of Md. Abdus Satter on his Doctor of Philosophy thesis entitled "The Arbuscular Mycorrhiza and Phosphate Rock in Rehabilitation of Tin Tailings with *Acacia mangium* and Peanut Agroforestry System" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.



MD. ABDUS SATTER

Date: 11 October 2000

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